Date:

EXPERIMENT – 2

AIM:

Simplify given Boolean expressions using Boolean algebra, realize circuits for optimized Boolean expressions, implement them using,

i. Basic gates only
ii. NAND gates only
iii. NOR gates only and verify their operations.

Boolean Expression:

i. **F1=ABC+A'B'C+A'BC+ABC'+A'B'C'**

APPARATUS:

Connection wires, power supply, power project board, resistors, LED, ICs

Sr. No.	Component	Specification	Quantity
1	AND Gate	IC 7408	2
2	OR Gate	IC 7432	2
3	NOT Gate	IC 7404	2
4	Two input NAND Gate	IC7400	3
5	Three input NAND Gate	IC7410	2
6	NOR Gate	IC7402	3

SIMULATION WEBSITE: https://www.tinkercad.com/

THEORY:

Boolean algebra is a system of mathematical logic, which uses capital or small letters of the English alphabet to represent variables or a function of the variables. In Boolean algebra, there is no subtraction and division. Only logical addition and logical Multiplication are performed. There are no fractions or negative numbers in Boolean algebra.

Boolean Postulates: Consider the binary numbers 0 and 1, Boolean variable x and its complement x′. Either the Boolean variable or complement of it is known as literal. The four possible logical OR operations among these literals and binary numbers are shown below.

$$x + 0 = x$$

$$x + 1 = 1$$

$$x + x = x$$

$$x + x' = 1$$

Similarly, the four possible logical AND operations among those literals and binary numbers are shown below.

$$x.1 = x$$

$$x.0 = 0$$

$$x.x = x$$

$$x.x' = 0$$

These are the simple Boolean postulates. We can verify these postulates easily, by substituting the Boolean variable with '0' or '1'.

Note: The complement of complement of any Boolean variable is equal to the variable itself. i.e., x''=x.

Boolean Laws and Theorems:

ASSOCIATIVE LOW: A + (B+C) = (A + B) + C; (A.B) C = A (B.C)

DISTRIBUTIVE LAW: A (B + C) = AB + AC; A + AC = (A + C) (A + B)

IDEMPOTANCE LAW: A.A = A; A + A = A

NEGATION LAW: A.A' = 0; A + A' = 1

DOUBLE NEGATION LAW: (A')' = A

IDENTITY LAW: A. 1 = A; A + 1 = 1

NULL LAWS: A. 0 = 0; A + 0 = A

ABSORPTION LAWS: A + AB = A; A (A + B) = A

CONSENSUS LAW: AB + A'C + BC = AB + A'C

TRANSPOSITION THEOREM: AB + A'C = (A + C) (A' + B)

DE MORGAN's THEOREM: (A + B)' = A' B' ; (A.B)' = A' + B'

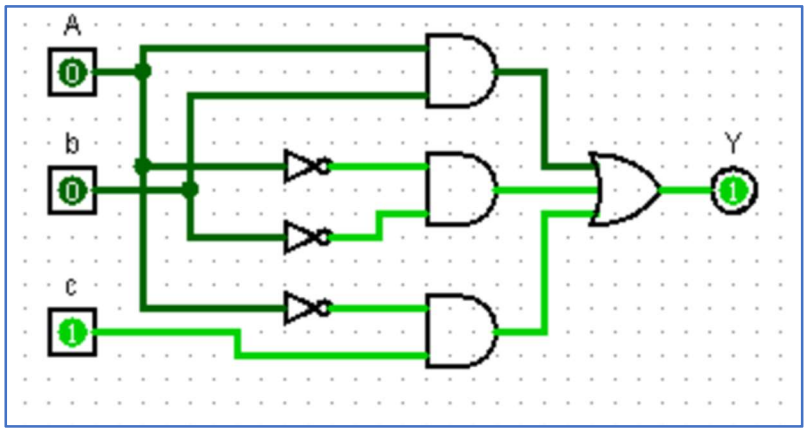
PROCEDURE:

i. Optimize Boolean expressions using Boolean Algebra.
ii. Design circuit for optimized Boolean expression using (A). Basic gates (B) NAND gates only and (C) NOR gates only and simulate them on software
iii. Verify operation of the circuits using truth table.

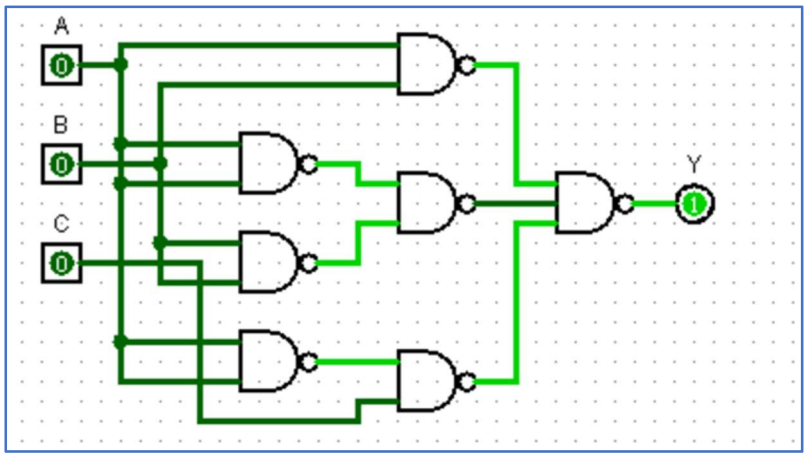
OBSERVATION:

ABC + A'B'C + A'BC + ABC' + A'B'C'
= AB(C + C') + A'B'(C + C') + A'BC
= AB + A'B' + A'BC
= AB + A'(B' + BC)
= AB + A'B' + AC

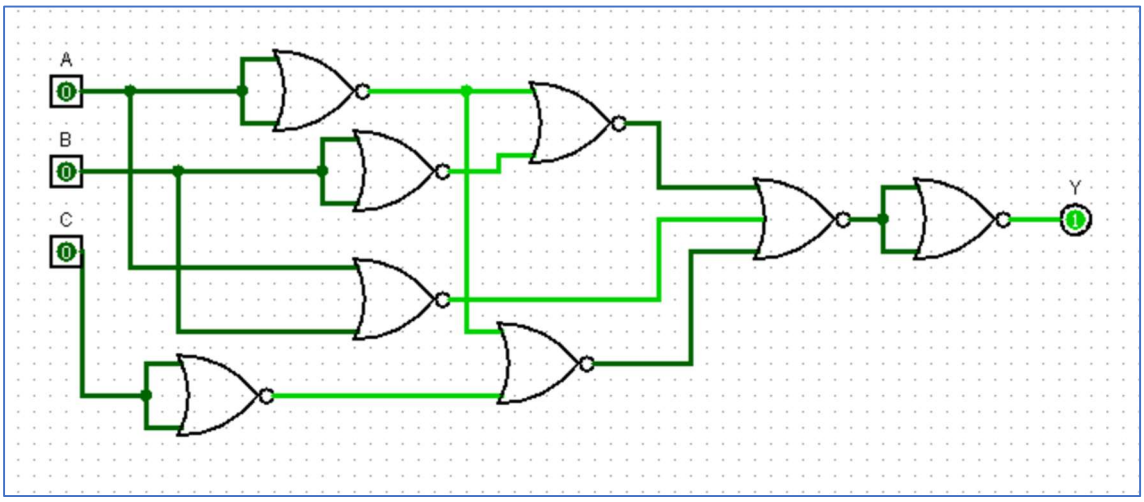
a) Circuit using Basic Gates



b) Circuit using NAND Gate



c) Circuit using NOR Gate



CONCLUSION:

By performing this practical we can learn about the Boolean algebra and learn to simplify a Boolean equation and also we can make logic circuits from the given equation.

Obtained Marks:
Faculty Sign:
Date:

ASSIGNMENT:

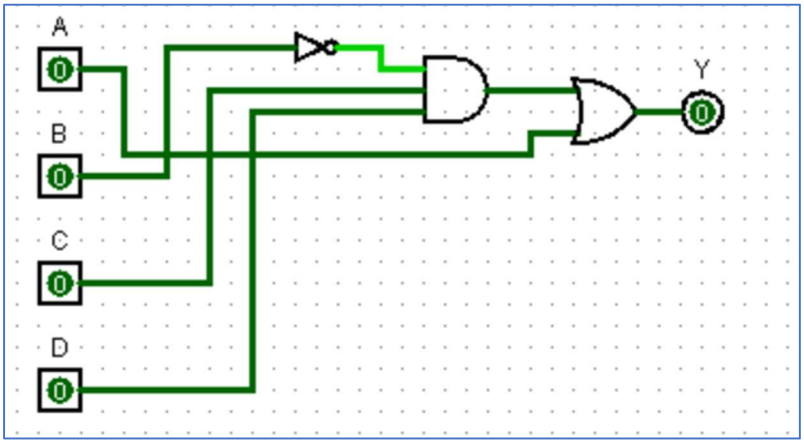
1. List out all Boolean theorems and postulates.
2. Simplify following Boolean expression and realize circuit of optimized expression using,
   i. Basic gates only
   ii. NAND gates only
   iii. NOR gates only and verify their operations.

   a) F1= (A+B+C) (A+C+D') (A+C'+D) (A+B')
   b) F2 = AC' + ACE + ACE' + ACE' + A'CD' + A'D'E'

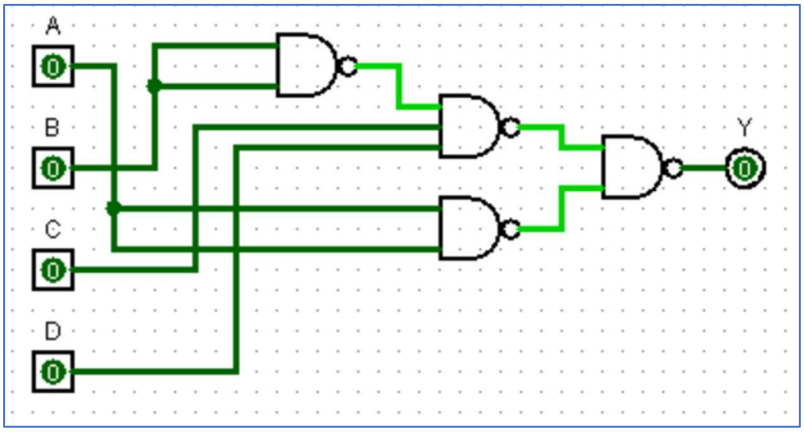
ANS – 2

- **F1 = (A+B+C) (A+C+D') (A+C'+D) (A+B')**
  = (ABC) + (ACD') +(AC'D)+(AB')
  = A(BC+CD'+C'D+AB')
  = A+[(B+C)(C+D')(C'+D)(A+B')]
  = A+[(BC+BD'+C+CD')(B'C'+B'D)]
  = A+[(C(B+1+D')+BD')(B'C'+B'D)]
  = (B' C D) + A

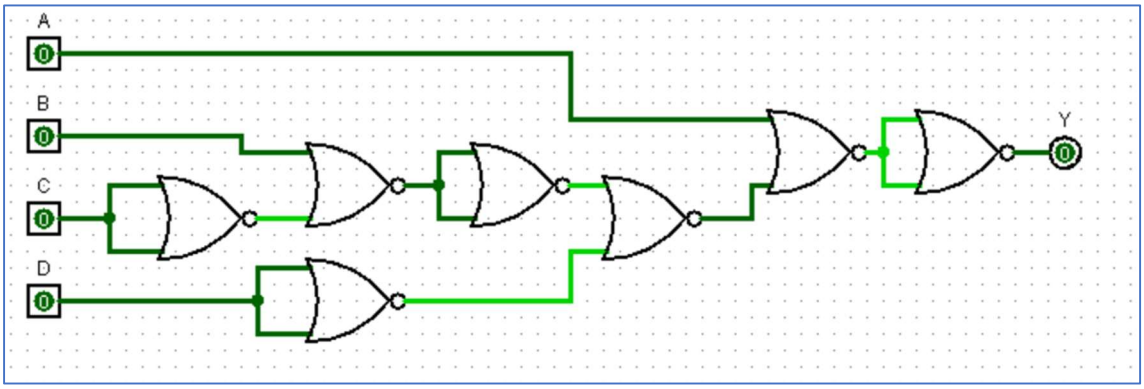
a) Circuit using Basic Gates



b) Circuit using NAND Gate



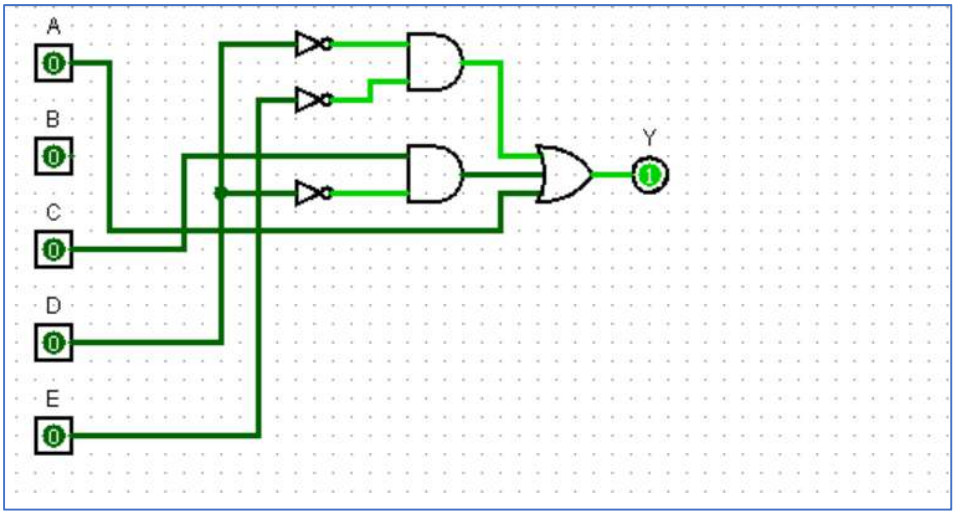
c) Circuit using NOR Gate



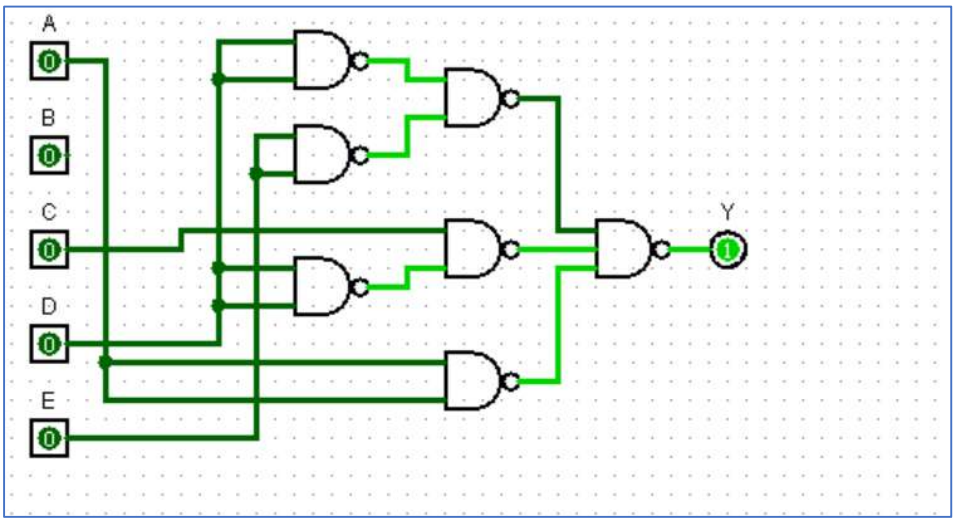
- **F2 = AC' + ACE + ACE' + ACE' + A'CD' + A'D'E'**

= AC’ + AC + ACE’ + A’CD’ + A’D’E’
= AC’ + AC+A’CD’+A’D’E’
= A+A’CD’+A’D’E’
= D’E’ + CD’ + A

a) Circuit using Basic Gates



b) Circuit using NAND Gate



c) Circuit using NOR Gate